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**Impacts of major traffic infrastructures on firms organisation of logistics and transport**  
*examples from the fixed links of Great Belt and Oresund in Denmark*

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**IMPACTS OF MAJOR TRAFFIC INFRASTRUCTURES  
ON FIRMS' ORGANISATION OF LOGISTICS AND TRANSPORT  
- EXAMPLES FROM THE FIXED LINKS OF GREAT BELT AND ORESUND IN  
DENMARK**

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**Abstract**

In this paper examples of consequences for logistical organisation of firms, stemming from new fixed links in Denmark, are described and discussed. It is argued that the most significant impacts of the new fixed links can be identified among transport firms. The effects on the activities among manufacturing and distribution firms seem to be far more limited due to the different levels of logistical decision-making of the firms. The impact on the logistical decisions-levels such as localisation and organisation of trading relations (supplier and customer links) has been very limited or even absent. A greater impact has been registered on the organisation of material flows and transport resources. The conclusions presented in this paper contributes to a more general discussion on how new major traffic infrastructures affect transport logistical systems in terms of fundamental structural changes and through increases in physical mobility.

**Keywords:** Freight transport; Spatial friction; Infrastructure investments; Logistics organisation; Freight traffic growth

**Topic Area:** B3 Logistics, Freight and Fleet Management

**1. Introduction**

The opening of the fixed links across the straits of the Great Belt and Oresund within the last six years has in both Denmark and Sweden been anticipated with great expectations of radical changes in the traffic and transport patterns, regional development, changes in firm's organisation, trading patterns etc. This article has been offset by some of the results of the research project *Infrastructures, transport and the environment – fixed links and the logistical map of Denmark*. The aim of the project was to study, what kind of influence the newly established fixed links across the Great Belt and Oresund has on selected types of firms and their organisation of logistics and transport. The research has been funded by the former Danish Transport Council and was carried out by a research team from FLUX – Centre for Transport Research, Roskilde University in Denmark<sup>1</sup>.

The expectations as to, what influence the fixed links would have has been manifold and even contradictory. On the one hand, the worry has been that the fixed links would increase the traffic flows due to the elimination of the "friction" caused by the ferries. On the other hand, the expectations reflected a desire to improve the planning,

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<sup>1</sup> The research team involved, besides the author of this article, Professor Lise Drewes Nielsen, Associated Professor Per Homann Jespersen, and Research Assistants Thomas Budde Christens, Jacob Lundgaard and Ulrik Røhl.

coordination and consolidation of the freight transport, and thereby not necessarily produce an increase in the traffic flows. However, there has been a lack of studies on the produced effects of the fixed links on firms' organisation of logistics and transport.

These considerations formed the basis for a study among selected examples of a number of case studies among selected examples of firms' within manufacturing, transport and distribution. These examples served as cases focused upon changes in the firm's logistical decision-levels:

- Changes in the firm's localisation
- Changes in the firm's trade relations
- Changes in the firm's organisation of product and transport flows
- Changes in the firm's organisation of transport resources



Figure 1: The location of the Great Belt and Oresund. The Great Belt link opened for rail traffic in 1997 and for road traffic in 1998. The Oresund link opened for both rail and road traffic in 2000.

Previous studies on the logistical effects of the fixed links across the Great Belt and Oresund have mainly focused upon impacts on manufacturing and service related firms or surveys of industrial sectors (Füssel, Skjøtt-Larsen, 1990; Björnland, 1997; The Great Belt, 1999). In the present study, the intention has been to look at specific examples of firm's and also to include the outermost link in the logistical chain – the transport firms.

In this paper it is argued that the most significant impacts of the new fixed links can be identified among transport firms. Hitherto, the effects on the activities among manufacturing and distribution firms included in the study have been limited. The impact on the logistical decisions-levels such as localisation and organisation of trading relations (supplier and customer links) has been very limited or even absent. A greater impact has been registered on the organisation of material flows and transport resources. A major conclusion that the study makes is therefore that the freight traffic growth in Denmark seems to be supported by the newly established fixed links, while more deeply founded changes in the firm's logistical organisation has so far been absent.

Section 2 presents an analytical approach that has served as a starting point for the present study and which offers an understanding of the underlying driving forces in a society of modernity that tends to affect more specific parameters related to transport and logistics. Section 3 discusses what kind of significance that the actors within the transport sector are attributed in studies of newly established traffic infrastructures impact on firm's transport and logistics. On the basis of the actor's capabilities to affect the organisation of logistics and transport, the themes under study in the case studies are sketched out in Section 4. Section 5 presents examples from the case studies of firm's possible changes – or lack of – in their organisation of logistics and transport on the basis of the newly established fixed links at the Great Belt and Oresund straits. Finally, the main conclusions from the study summarised and are discussed in Section 6.

## **2. New traffic infrastructures effect on transport and production systems**

New traffic infrastructures are not isolated phenomena, which are established independently of their contemporary context – political, economic, social etc. Thus, the newly established fixed links can also be seen in the context of underlying structures and tendencies embedded in post-modern society. Post-modern society can be characterised by the *compression of time and space* (Harvey, 1990), which is a state caused by – among other things – the development of new communication and transport technologies, and networks. Communication and transport networks can be perceived as intermediaries of new forms of industrial organisation – both in a literal and conceptual sense. Three main characteristics in the theoretical discourse of the post-modern society can be related to the conceptualisation of post-modern transport and logistics. The concepts reflect a development, where distance and time is perceived in new ways caused by the instantaneous connectedness of information, product and transport flows (Beckmann, 1999; Drewes Nielsen, Oldrup, 2001).

The development of transport and information technologies has the consequence, that distance between localities and individuals is perceived to be shrinking. This can be conceptualised as *spatial compression* (Harvey, 1990). Another, closely connected, tendency in post-modern society is the *time compression* that similarly is contingent on – among other things - the technological development of transport and communication. The effects are reflected in the way that activities, to a larger extent than previously, are coordinated independently of geographical distances. One can therefore conceptualise this development as a change in the perception of time from “scheduled time” to “instantaneous time” (Urry, 2000). The third characteristic of post-modern society, that affects the manifest transport and mobility, is the *flow network*. This characteristic reflects a change in the relations among individuals, organisations, firm's etc. Information and products thereby has a greater tendency to flow continuously among firm's than previously, a tendency that has to be understood in connection with the trends of spatial and time compression (Castells, 1997).

These three characteristics or driving forces of post-modern society function as preconditions for the analytical coupling between general societal changes and corresponding changes within logistics and transport. This coupling should not be perceived as a simple cause-effect relationship, where changes on the societal level directly result in changes on the more specific levels of firms, organisations and individuals. The relationships should instead be seen as mutually affecting each other and thereby treating changes in transport and material flows as capable of affecting the spatial, time and relational structures within society.

## **2.1. Derived concepts of transport logistics**

The above-discussed meta-concepts from the theoretical discourse concerning post-modern society cannot directly be the subject of empirical analysis on transport and logistics. In the study of transport logistical effects of the newly established fixed links it has therefore been necessary to apply four mediating concepts, which more directly and specifically reflect the transport logistical themes of the three meta-concepts (Drewes Nielsen, Jespersen, Petersen, Gjesing Hansen, 2003): distance, speed, frequency and time-windows. These concepts have been used to develop an analytical framework based upon themes that often are included in logistical analysis (Cooper, Black, Peters, 1994; McKinnon, 1998).

### *Distance – how far ?*

There is a tendency that firms sell their products and buy their supplies at ever more distant locations. The transport distance of materials often becomes longer when production processes are centralised or when new supplies and markets are expanded worldwide. This spread of activities takes place on local, regional, national and international levels.

### *Speed – how fast ?*

The demands on the speed for delivery of goods have been increased resulting from the expectation of customers that lead-time should be continuously reduced. The demands of quick delivery results in the use of faster transport means, which affect the customer's choice of transport modes, the ability to optimise load capacity and the environmental impacts of transport.

### *Frequency – how often ?*

Both manufacturing and retail firms require more frequent deliveries. This demand can for example be motivated by the reduction or elimination of internal warehousing. The growth of more frequent deliveries can result in a less efficient transport in terms of load capacity and a growth in traffic volumes that – among other things – generate negative environmental impact.

### *Time-windows – when ?*

When demands for delivery is heading towards greater precision and smaller time-margins, then it becomes more challenging to plan and coordinate distribution, and utilise transport and human resources efficiently. The demand for more tight delivery schedules, is – among other things – a result of logistical set-ups like just-in-time, which requires continuously material flows to and from the firm's.

The above concepts can be perceived as reflecting underlying tendencies, which affect the decision-making of firm's on their organisation of logistics and transport. New traffic infrastructures can possibly change or enforce the significance of these underlying tendencies concerning compression of time and space. But, it is worth noting that it could also be the case that the general tendencies within industrial and logistics organisation marginalize the effects of new traffic infrastructures on firm's organisation of transport and logistics.

## **3. The transport sector – a neglected system of actors ?**

Freight transport is an activity that is derived from – among other things – firm's decisions concerning localisation and organisation of production and distribution. Firm's are embedded in systems or networks of supplier and customer relations which consist of a flow of raw materials, sub-supplies and end-products. Distance to and accessibility between the individual firms in a production system is of central importance. Furthermore, the localisation and quality of the traffic infrastructures are counted as essential factors for, how firms and production systems evolve and succeed.

However, the freight transport among Danish and European firms is often outsourced to external transport and forwarding firms. In Denmark approximately 70 pct. of the road-based freight transport is organised by hauling and forwarding firms (Bjerregaard, et.al., 1995; Gjesing Hansen, 2000). This gives the transport firms a mediating role between, on the one hand, the firms buying transport services and, on the other hand, traffic infrastructures (see Figure 2).

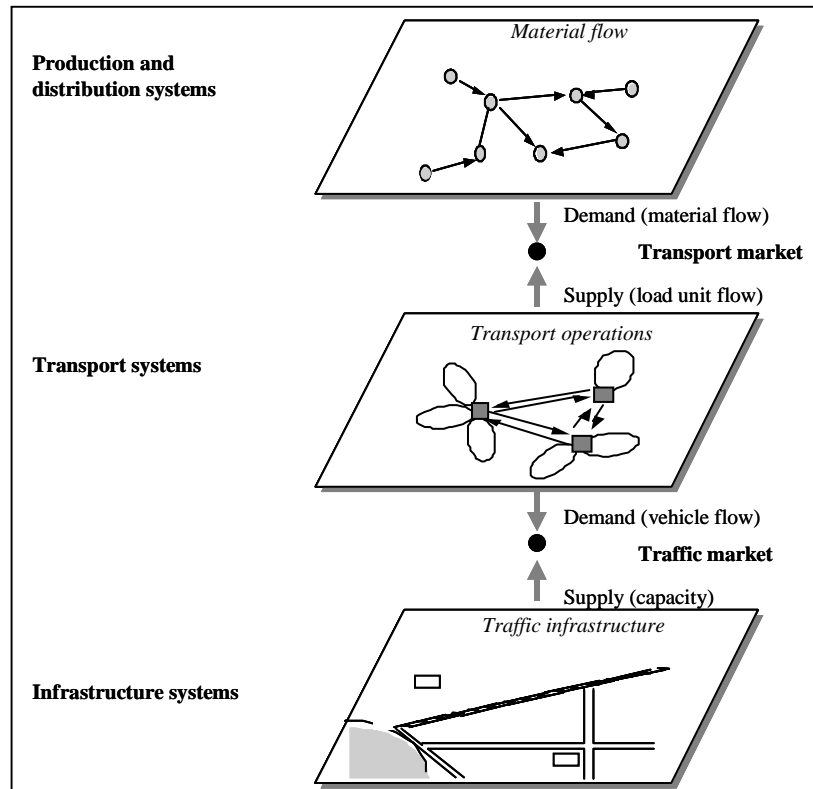


Figure 2: Systems of actors and activities, which are central in the relationships among firms transport and infrastructures (applied model from Wandel & Ruijgrok, 1993).

Figure 2 illustrate a frame of reference of the functional relations among manufacturing/distribution, transport and infrastructure systems. The first layer represents the organisation of production and distribution firms: the logistical organisation of *material flows* between firms in production systems results in a transport demand. The second layer reflects *transport activities*, which entails the handling of material flows between shippers, recipients and loading terminals. The transport flows consist of vehicles, trailers, containers etc. These transport flows generate a demand for traffic capacity. The third layer represents *traffic infrastructures*, which establish the supply of traffic capacity for the traffic flows in the form of roads, bridges, tunnels etc.

As shown in the framework presented in Figure 2, there is a causally established relationship between demand for transport and the corresponding transport services offered. It is also explicitly illustrated that the traffic infrastructures affect which routes the material flows – between firms and their suppliers and customers – *can* follow. The transport firms are situated in the middle of these two systems and having a capability to affect how the transport of goods *actually* takes place and which routes *actually* are followed. Transport firms thereby represent a more or less central coordinating function for the material flow in production systems – depending on the competencies of the transport firms (Gjesing Hansen, 2000; Gjesing Hansen, 2002).



Studies on the relationships between new traffic infrastructures and the economic development among firms and regions tend to include effect analysis on production and distribution firms only. Results from these studies and analyses have primarily identified a limited effect of traffic infrastructures on firms' organisation and economic development. These studies provide examples from Denmark, the rest of Europe and North America, where the supply of traffic infrastructure in general is of a high quality and dense (Forslund, Karlsson, 1991; Hjalager, 1993; AKF, 1993; Maskell, 1994; McKinnon, 1997; Burmeister, Colletis-Wahl, 1998; SACTRA, 2000). In countries and regions with a generally low accessibility, new traffic infrastructures can of course still be identified as main drivers in the economic development of countries, regions and firms (Hoyle, Smith, 1992).

The absence of significant and radical effects of new traffic infrastructures on the economic performance and development of firms might therefore be due to the presence of an already well-functioning traffic infrastructure system. Another plausible explanation might be that studies of effects tend to focus narrowly on manufacturing and service industries. The mediators of the material flows – transport and forwarding firms – are often excluded from this type of study. The relevance of including transport and forwarding firms in such studies can be found in the ongoing tendency within these firms to expand their activities to include third party logistics services for their customers – e.g. warehousing, packaging, logistical management etc.

Based on the findings and tendencies discussed above, it seems relevant when undertaking studies of effects of new traffic infrastructures to apply a transport logistical chain perspective (Drewes Nielsen et.al., 1999). The effects of the newly established fixed links across the Great Belt and Oresund on firm's organisation of transport and logistics may therefore, it is argued here, depend on which types of logistical chains they are part of, and which function they exert in the chain. In the next section, the design of the study is presented, as are the kind of research themes that structured the analysis of the empirical findings.

#### 4. Research design and methodology

Based on empirical findings and experience from previous research projects on freight transport this study applied a transport logistical chain perspective. Six firms from three different positions in logistics and transport chains accepted to take part in an interview-based study of their organisation of logistics and transport of in- and outgoing material flows.

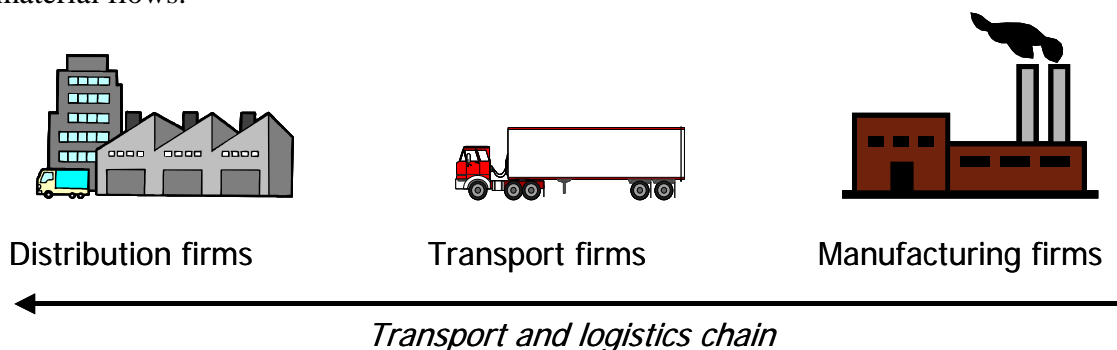


Figure 3: The focus of the study on three different types of firms in a transport and logistics chain perspective: manufacturing, transport and distribution firms.

The firms represented activities within manufacturing, distribution and transport:

- 2 SME's within the furniture manufacturing industry (referred to in this article as M1 and M2)

- 2 large distribution firms within the retailing sector and wholesaling sector of pot plants (referred to in this article as D1 and D2)
- 2 medium sized road haulage firms (referred to in this article as T1 and T2)

Geographically the firms are located in different regions of Denmark (Jutland, Fuen and Zealand) and they also represented different sizes of firms in terms of number of employees and turnover. The selection criteria of the firms was to pick examples of different types of functions in transport and logistical chains, and not representative of different branches– see Figure 3. It was also the intention to include both firms that were and firms that were not affected by the fixed links. Thus the objective of the study was not only to identify and document changes in the organisation of transport and logistics of these firms, but to increase the knowledge of *how* this type of traffic infrastructures affects different types of firms in the logistical chain.

Qualitative interviews of managers were used in the six cases to find out how the firm's organised their ingoing and outgoing transport and logistics, and also how far this organisation had undergone major changes within the last 5-10 years. In relation to this, we asked the managers what kind of circumstances – including the new fixed links – had caused these organisational changes.

Seen from the individual firm's point of view, decisions concerning actions on transport and logistics can take place on many organisational levels – from the management's decisions to open or close a firms activities to the driver who makes the route decisions concerning the deliveries. On this basis Allan McKinnon (1998) has developed a hierarchy of logistical decision-levels, that reflects important spaces where decision-making affecting the transport and logistics of firms take place. These are:

- *Logistical structures*: e.g. number and localisation of factories, warehouses, administration and terminals.
- *Trading relations*: localisation of suppliers and customers that constitute a manifest network of material and transport flows.
- *Organisation of material and transport flows*: planning and implementation of production and distribution activities, which are transformed to specific material and transport flows to and from a firm.
- *Organisation of transport resources*: e.g. the use of own or external transport modes, route choice, transshipment via terminals and capacity utilisation.

These four levels formed the basis for the themes in the interviews and thereby structured the knowledge that was collected from the six case studies of selected firms.

## **5. The impact of the fixed links on selected types of firms**

This section presents examples from the six firms. These examples illustrate effects or the lack of effects due to the new fixed links across the Great Belt and Oresund on the firms organisation of logistics and transport.

### **5.1. Logistical structures**

The interviews indicate that changes in the firm's physical location of activities (production, warehouses, administration and terminals) are relatively resistant to immediate changes in the accessibility for in- and outgoing transport flows. None of the firms interviewed has been able to identify changes in the firm's logistical structures, which had taken place during the last 5-10 years as a result of the new fixed links.

Examples of conditions that to a larger extent affect the firm's localisation of their own activities were as – among other things – decisions concerning in- and outsourcing of activities. For the interviewed manufacturing firms (within furniture production) this was exemplified by the issue of production of low or high value furniture to a



standardised mass market or order-specific customers. In the latter example, the furniture firm reduced its own physical facilities by out-sourcing activities to dedicated and specialised suppliers. One of the road haulage firms did establish a warehouse, which could serve as an intermediate storage and distribution facility for its major customers. These decisions that are related to the firm's physical localisation of its own facilities were affected by other circumstances than the newly established fixed links.

Nevertheless, it is also necessary to consider the decisions related to logistical structures in a time perspective. This was illustrated in an interview at one of the road haulier firms: *"(...) that the future will cause changes on this issue – that is within 5-10 years. When future warehouses and logistical centres are to be located, then the existence of the new Oresund link will be taken into consideration. But, because the investments [in new terminals and warehouses] are huge it means that existing facilities are not abandoned in the short run. (...) Zealand is facing a great future as logistical centre for the Nordic countries, because a large number of consumers and customers can be reached from this region. Similarly, Swedish companies will in the future, to a larger extent, locate in the vicinity of Malmö rather than Gothenburg or Stockholm, because there are better possibilities for transport by ship, lorry and aeroplane"* (Interview, T1).

Thus the transport firm points to the fact that time represent a kind of inertia in terms of sunk investments in existing logistical structures. This could result in more significant changes in the long time-perspective of the logistical structures through re-locations caused by the new fixed links.

## 5.2. Trading relations

None of the interviewed firms could identify changes in the location of suppliers and customers as a consequence of the fixed links across the Great Belt and Oresund.

At the two manufacturing firms in the study – M1 and M2 – the choice of suppliers has not been affected by the fixed links, for example in the form of increased accessibility to alternative suppliers. The most important parameters for choice of suppliers among these firms are their competencies and qualifications in relation to the complete furniture product, while transport costs do not play any role in the choice of Danish suppliers. Neither, had the customer relations been significantly changed within the last 5-10 years and these had no relation to the fixed links. Interestingly though, one of the furniture producers did notice that furniture retailers and wholesalers on Zealand – as a consequence of the fixed link across the Great Belt – today operated to a larger extent West of the Great Belt than previously. This could indicate that the immediate effects of the fixed links on the logistical chains are felt more significantly in the retail and distribution parts than in the manufacturing parts of the chain.

It was also stated by the two retail and distribution firms in the study that the fixed links had not produced any changes in the location of suppliers and customers. Nevertheless, there were indications that the present location of suppliers and customers in the near future could be changed. At one of the distribution firms – D1 located on Fuen – this was primarily due to a possible re-organisation of existing terminals on the island of Fuen and in Jutland. This re-organisation will lead to a centralisation of the firm's distribution activities concerning potted plants from the market gardens in Denmark to customers in Denmark and Europe in terms of a single terminal. This centralisation and thereby possible change in the supplier and customer network was caused by a strategic desire to make a more distinct division of activities within a large companies sub-divisions respectively in Fuen and Jutland.

For D2 located near Greater Copenhagen – a regional division of one of the leading retail companies in Denmark (app. 40 pct. market share) – the fixed links had not affected the inward bound transport to the warehouses and terminals through changed locations of suppliers or customers. The “customers” of D2 are the grocery stores of its parent company on Zealand and it has therefore not been affected by the fixed links. The parent company’s grocery stores in the Western parts of Denmark (mainly on Fuen and in Jutland) are supplied from two regional terminals in Jutland. This regionalisation, into an Eastern and a Western distribution network, is divided by the Great Belt and the fixed link has not affected this division: *“The regional terminal at D2 [in Zealand] deliver goods to 400 grocery shops on Zealand. In relation to the fixed link across the Great Belt, we have tested the possibilities of also distributing to our grocery shops on the Eastern part of Fuen [on the Western part of the Great Belt], but due to the price of using the [fixed] link, the costs proved to be too high – even though [the parent company] was offered a discount due to the traffic volumes. If the price was lowered considerably, the distribution from the terminal on Zealand to shops on Fuen would probably be profitable”* (Interview, D2).

In the cases of the two freight haulage firms in the study, it was not possible to identify examples of changes in the location of suppliers or customers as a consequence of the fixed links. However, it is likely that particularly transport firms’ supplier and customer relations could be subject to changes, because transport firms often have far more changeable and short-lived relations than manufacturing and distribution firms.

### **5.3. Organisation of material and transport flows**

Among the interviewed firm’s, there was a distinct differentiation of, how directly the new fixed links have affected their organisation of material and transport flows.

The interviewed manufacturing firms had in general not experienced any impacts from the fixed links on their organisation of material flows to and from their firms. Other factors played a greater role on how the firms plan and organise their internal and external logistics. At the furniture producing firm M2, one of the most important and critical elements in the logistical planning is the co-ordination between the inward and outward bound material flows. Sofas and chairs are order-produced and the minimisation of the internal storage of finalised furniture is a central strategy. The consequence is, that the lead-time – e.g. the time it takes from the order is confirmed to actual delivery at a customer – is 3-4 weeks. But this lead-time is furthermore extended by including the time used for planning the co-ordination of inbound material flows of raw materials and unspecialised components. M2 is therefore obliged to operate with a considerable storage capacity of a variety of standardised components that often require a delivery time far beyond the 3-4 weeks of finally produced furniture. The potential time-savings of the new fixed links in minutes and hours are in this context without any significance for the firm.

Among the distribution firms, the effects of the fixed links are more significant – although a number of other factors in general are of greater significance for the firm’s decision-making on organisation of inward and outward bound material flows.

At D2, the fixed link across the Great Belt had affected the organisation of the transports of fresh goods between the regional terminals of COOP Denmark in particular: *“There has been a rise in the number of these transportations and the time saved from the new fixed link across the Great Belt has increased the flexibility in organising these transportations. However, the external road haulage firms still often use the ferry link between East-Jutland and West-Zeatland to transport dry goods*

*between the terminals of Greater Copenhagen [on Zealand] and Aalborg [in Jutland]”* (Interview, D2).

Other factors have played a far more significant role in generating a growth in the traffic flow of D2 and its parent company than the above-referred higher frequency of internal material and transport flows between regional terminals in the East and West of Denmark. Examples include new concepts such as “Fresh Milk”, a strategy of milk delivery from farmers to the grocery stores within 24 hours - which increases the throughput for milk products, a concept that is beginning to spread to other types of fresh goods. The “Fresh Milk” strategy is also an attempt to reduce the import of milk from Germany and the Netherlands, because imported milk cannot be distributed within 24 hours to Danish grocery stores and shops. This distribution concept has led to an increase in the frequencies of deliveries from the regional terminals of D2’s parent company to its grocery stores: *“[Caused by the volumes] the road haulage firms have to distribute to the stores twice a day (...) even though the terminals storage capacities are big, there is simply no space for it. If all (the grocery stores) have to wait for fresh milk, then it also becomes a space problem for them, because the volumes are so enormous”* (Interview, D2). Consequently, the time-pressure that the “Fresh Milk” concept generates results in a need for more frequent distribution between regional terminals and the grocery stores. This is also due to that the road haulage firm’s do not want to increase the number of vehicles in order to distribute all the milk in one delivery round, but instead use the same lorries for at least two trips per day with fresh milk distribution: *“If they [the transport firm’s] are forced to use a lot more lorries, which have to run for a shorter period – then they become unhappy and want more compensation for their transport services”* (Interview, D2).

The development of an increased time-pressure on the organisation of material and transport flows is also a well-known phenomenon at the pot plant-wholesaling firm D1 located on the island of Fuen. This is partly due to the changed expectations among the customers regarding shorter delivery time, but also partly due to the effect of the fixed link across the Great Belt. The wholesaling firm packs and distributes pot plants from greenhouse gardens on Fuen to mainly the retailing sector in Denmark. A large part of the deliveries are ordered on the same day of delivery. This means that the greenhouse farmers typically receive the orders directly from the retailers between 8 and 11 a.m., thereafter the pot plants are collected and transported to the wholesalers terminal for final packaging. Finally, the consignments of pot plants are distributed to the customers late in the afternoon.

Even though the new fixed links across the Great Belt and Oresund has increased the time-pressure in the logistical chain, it has not had any direct consequences for the organisation of storage and packaging – a core-activity at the wholesaling firm. The impacts have primarily been visible in the transport planning activities: for example the fixed links have broadened the scope for scheduling deliveries due to the improved stability in crossing the Great Belt and Oresund by bridge/tunnel instead of ferries. Furthermore, the customers of the pot plant wholesaling firm pay attention to the new opportunities: Previously the customers were obliged to order their goods the day before delivery, but this lead-time has been reduced substantially to delivery within the same day of ordering.

For a distributing firm like D1 the fixed link across the Great Belt has had an ambiguous impact on the logistics organisation: On the one hand, the replacement of the ferry link has eliminated a transfer point, which represented an uncertainty in relation to planning of departures and arrivals of deliveries. The time-tables of the ferries functioned as time-windows, which the deliveries from D1 to their customers had to

match precisely. On the other hand, the fixed link has amplified the development of new time-windows at other stages of the logistical chain. The transit time from D1 to larger customers on Zealand for instance was reduced by app. 1 hour. Due to the short lead-time, the transit time plays a relatively more significant role than at the logistical organisation of the furniture firm's referred to above. This results in a tighter co-ordinated transport and logistical chain that includes more narrow time-windows at the large customers – e.g. the time margin for delivery that is acceptable at the customer. Typically, this means that if a lorry arrives outside these time-windows, then the haulage firm's or the suppliers (for example D1) are penalised an extra cost by the customer.

Even though the effects of the fixed links among the studied examples of manufacturing and distribution firm's seems limited or non-existent, the effects proved to be more significant at the outermost link of the logistical chain – the freight haulage firms.

At the freight haulage firm T1, near Greater Copenhagen, the transport flows have significantly been affected in terms of increased speed, increased frequency and precision, and through a growth in transported distance. For the haulage firm, the Great Belt link has contributed to a reduction in uncertainty in the planning of transport flows by a better regularity of the trips between Denmark and for example France. A major market for the firm is transport of airfreight between Copenhagen Airport and other Northern European airports – a transport market where the time factor is of crucial importance. The establishment of the fixed Oresund link has lead to an increase in the firms' departures between a terminal in Malmö (Sweden) and at Copenhagen Airport from 3 to 9 departures. Today the firm uses smaller lorries due to the fact that the freight volumes have not increased similarly. The reason for the increased frequency is that the firm tries to solve a capacity problem, that previously meant that extra-lorries had to be forwarded with rather small consignments: *"The reason for increasing the number of departures has been, that previously – when we late in the evening discovered that we needed more loading capacity than four flight-pallets, then we could risk sending the extra flight-pallet with an extra lorry, because it definitely had to be at Copenhagen the following morning. These situations are, today, handled more flexibly by an increase in frequencies"* (Interview, T1). However, it has not been possible to avoid a certain number of trips, where the loading factor has been very low: *"(...) Approximately 3-4 times a week the transported volumes are far below the actual loading capacity of our lorries"* (Interview, T1). This statement can be seen in the general ongoing process that was already set into motion before the opening of the fixed link across Oresund: The rising demand for high-frequent transport connections due to the expectations among transport customers for as flexible departures and arrivals of trips as possible. A transport demand, which reflects the conceptualisation of just-in-time logistics.

At the second road freight haulage firm in the study, T2 located in the middle of Jutland, the establishment of the fixed Great Belt link has resulted in one less time-window to consider in the daily planning of transport and distribution activities. Thus the establishment of the fixed link has resulted in more flexibly organised transport systems across the Great Belt and the trip planning has improved due to the replacement of the ferries: *"We can organise the trips without considering the weather conditions as a pre-condition for punctual delivery. And the time-margin, that we have to plan for trips between Fuen and Jutland to Copenhagen in order to calculate the exact time for arrival of a consignment, has changed significantly. If we didn't catch a ferry [before*

*the opening of the fixed link], then we had to wait for three quarter to one hour before we could take the next ferry – if this was not over-booked” (Interview, T2).*

According to the road freight haulage firm, the establishment of the fixed link has lowered the costs of crossing the Great Belt, but this cost-reduction has been transferred to the transport customers. When the prices for crossing the fixed link were published, the contracts with the largest customers of the road freight haulage firm were re-negotiated – on demand of the customers. Before the establishment of the Great Belt Link, the ferry cost for road freight haulage was approximately 148 euros. After the opening of the Great Belt Link, the price-level has been lowered to approximately 87 euros.

The road freight haulage firm experienced a greater pressure for optimising the utility of the loading capacity before the opening of the fixed link. The high capacity utilisation was primarily reached by consolidating return loads. Today, where costs of crossing the Great Belt have been reduced, the pressure for a high capacity utilisation has changed.

For the road haulage firm T2, the Great Belt Link has resulted in more frequent trips on some of its routes. The Great Belt Link has also lead to an increased use of express deliveries with short notice and therefore has the haulage firm invested in a number of small lorries and vans. The transit-time has been compressed after the opening of the fixed link across the Great Belt. This seem to be due to a perception among the transport buyers, that the transport distance has been reduced by the Great Belt Link and also that the transport costs has been lowered for transport between the East and West of Denmark: “(...) *we have felt that [the customers] do not speculate on the costs the same way as before. It is easier to send some goods to Zealand today [from the peninsula of Jutland]. Transport buyers know that there is a different time-horizon. There is another cost-structure*” (Interview, T2). It is therefore not only the supply of capacity in the transport system, that generates more transport, but also due to the increased transport demand facilitated by expectations among transport buyers, that the transport is managed more frequently, faster and cheaper than before the fixed links were established.

#### **5.4. Organisation of transport resources**

The establishment of the fixed links has affected the way the studied firms’ organise their transport resources differently. The manufacturing firms’ did not perceive any changes in the way their in- and outbound transports were organised after the opening of the fixed links. According to the furniture producing firm M1, the Great Belt Link has not generated a greater flexibility in the logistical planning within the firm – even though the transport firms today are not restrained by the fixed schedules of the former ferries. However, the frequent time-schedule of the former ferry link is also given as a reason by the firm as to why there has not been noticed any remarkable change in the transport quality due to the fixed links. The firm has neither experienced a greater pressure for quicker deliveries in the last 5-10 years nor put a greater pressure on their transport providers for faster and cheaper transport services. According to M1, this is mainly due to the firms high-value products, which serve a market where customers’ rank product quality higher than a low lead-time. The total lead-time for producing the furniture products usually amounts to 4-6 weeks (from receiving the order to being ready for delivery), and therefore the time-saving of one hour from the fixed link across the Great Belt does not play any significant role for the furniture producers own logistical organisation. The absence of changes in the organisation of in- and outbound transports is probably due to the fact, that this firm – like the majority of Danish



manufacturing firms – is not directly involved in the coordination and execution of the actual transport. As described above, most manufacturing firms' use external transport firms for coordinating and handling their in- and outbound transport and often also logistics activities. The experienced effects of changes in the organisation of transport routes, choice of transport modes, re-loading and consolidation of goods, are often located at the two other types of firms' involved in this study – distribution and transport firms. Among these firms the effects on their organisation of transport resources were more significant.

The wholesaling firm D1 expected– before the opening of the Oresund link, that this link would become the preferred distribution channel to customers in Sweden. The actual transport pattern has so far been very different: *"... with the pricing policy so far, it has not been interesting and much too expensive. In short, this means that all goods destined for customers in Helsingborg and further north are still transported via the ferries [Helsingor-Helsingborg]. (...) this is due to the price of the fixed link. The ferries take 20 minutes and sail very regularly. Previously, there was a lot of waiting-time at the ferries, but this is rare now. There is no incentive to use the fixed link. If you drive from Malmö towards Stockholm, then you have to drive via Helsingborg anyway. It gives you 60 kilometres extra driving for reaching customers north of Helsingborg, if you use the fixed link instead of the ferries"* (Interview, D1).

According to the wholesaling firm, a transfer of transports from the ferries to the fixed link will depend on a lowering of the prices. Current rules on resting-time for drivers have also a great influence on the choice of transport channel. Transport to destinations as Oslo and Stockholm can be reached by using only one driver, because the maximum time-limit for driving (10 hours) is not exceeded, when the drivers choose the ferry-link.

Among the road haulage firms' in the study, the establishment of the fixed link across Oresund has only had significant influence for distribution and picking-up of goods in the Malmö area. This is especially the case for T1, which among other things transports air cargo between Copenhagen Airport and a freight terminal in Malmö. For both the studied road haulage firms it is not profitable to drive to destinations north of Malmö via the fixed link. Therefore, both firms use the ferries for these destinations.

In general several of the studied firms' pointed to the fact that the fixed Great Belt Link replaced a ferry link in an already existing and heavily used transport corridor between the eastern and western parts of Denmark. Therefore the establishment of this fixed link has not had any significant consequences for the route choice among transport and distribution firms' organisation of transport flows. On the contrary, the fixed Oresund link represents a new corridor for road and rail transport between Denmark and Sweden, since it mainly replaced existing passenger ferries between Copenhagen and Malmö. One could therefore anticipate more dramatic changes in the route choice for transports across Oresund – *from* the still existing ferry link *to* the new fixed link. But, this is not the case as indicated in this study and also verified through current statistics on the transport flows across Oresund.

## 6. Conclusions

The results of this study should be seen in relation to the expectations concerning whether the new fixed links would generate an increase in traffic work due to the elimination of the ferry links or the fixed links would lead to improvements among firms logistics organisation for coordinating and optimising their transport activities.

In the study are their indications, that the fixed links have supported a dramatic rise in the freight traffic on the roads across the Great Belt and Oresund. Other factors than



the fixed links have also had an influence on this growth – for example a general tendency in the firms' organisation of internal and external logistics that reduce the storage capacity at manufacturing firms and thereby increase the demand for frequent in- and outbound transport flows. The fixed links seem to contribute to the growth in the traffic work, but not necessarily to a similar growth in transported goods. Among the road haulage and distribution firms' it was stressed that the fixed links improved the ability to organise the transport with more frequent deliveries. The transport firms' also experienced, that transport buyers in general expected greater precision in the pick-up and delivery of consignments after the establishment of the fixed links. On the one hand, and seen from the perspective of the individual transport buyer, this represents a clear improvement in the transport quality. On the other hand, it also makes it difficult for the road haulage firms' to coordinate and optimise the capacity utilisation.

The study has contributed knowledge on how the new fixed links across the great Belt and Oresund affects different types of firms' logistical decision-making. The fixed links are primarily affecting the transport firms and partly distribution firms. On the contrary, the studied manufacturing firms' have not been able to identify any changes in their location of own facilities or location of their suppliers and customers due to the fixed links. Neither have they experienced any changes in their organisation of material flow or transport resources. Instead, other factors were mentioned as being more significant than the time-savings and route choices that the new fixed links enabled. Among the transport and distribution firms, it was stressed that the fixed links enabled a more flexible trip planning that is often a core activity within these types of firms. However, these firms also experienced a tendency among their customers to tightening the existing time-windows for picking-up and deliveries due to expectations for faster and more accurate transports. Thus it seems the increased flexibility enabled by the fixed links has ambiguous effects on the ability to organise transport and logistics in an efficient way.

In relation to the above results, the study also clearly reveals that it primarily is the logistical decision-levels closest on the actual and operational organisation of material and transport flows that has been affected by the fixed links. On the contrary, it seems that logistical decisions related to re-location of own firms activities or re-location of suppliers and customers have not been affected by the new fixed links. It is however important to note that a study over a longer period of time could probably show more significant effects of re-location. Factories, storage, terminals etc. represent sunken investments that in a short-term perspective not easily can be re-located.

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